EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

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Abstract

The User Requirements Document (URD) documents the ATM Stakeholder Needs expressed by the Aviation Community during user consultation workshops held by EUROCONTROL in 1994 and 1998. These statements have been used as input to the development of the ATM Target Concept and the ATM Strategy for 2000+.

Volume 1 of the URD contains summaries only. More detail can be found in Volume 2.

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CONTACT PERSON : Hartmut Koelman	**TEL :** 3306	**DIVISION :** DED1

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AUTHORITY	NAME AND SIGNATURE	DATE
Head of Section DED1.1	Bernard Miaillier	
Head of Division DED1	Helmut Schroeter	

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FOREWORD

The User Requirements Document (URD) documents the ATM Stakeholder Needs expressed by the Aviation Community during user consultation workshops held by EUROCONTROL in 1994 and 1998. These statements have been used as input to the development of the ATM Target Concept and the ATM Strategy for 2000+.

Edition 1.0 of this document was published in 1995. This update brings the document in line with the latest developments.

Volume 1 of the URD contains summaries only. More detail can be found in Volume 2.

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EXECUTIVE SUMMARY

The User Requirements Document (URD) documents the ATM Stakeholder Needs expressed by the Aviation Community during user consultation workshops held by EUROCONTROL in 1994 and 1998. These statements have been used as input to the development of the ATM Target Concept and the ATM Strategy for 2000+.

Volume 1 of the URD contains summaries only, and is intended to familiarise the reader with the body of knowledge acquired during the stakeholder consultation process. More detail — as well as formal traceability and configuration control — can be found in Volume 2.

Reflecting a process of stakeholder consultation, the statements in this document have not been interpreted as precisely worded 'requirements' in the strict (committing) sense of the word, but rather as high level material to be taken into account to maximise stakeholder satisfaction in the continued development of ATM in Europe. Compared with edition 1.0 of the document, the new EATCHIP terminology is now used whereby the broader term 'stakeholder' is preferred over the word 'user', and the statements are now called 'Stakeholder Needs' rather than 'requirements'.

In 1994 the workshop participants particularly emphasized the the need for:

- developing ATM as a network for "gate-to-gate" operation, i.e. covering all phases of a flight. This implies a strong consideration of measures to enhance airport capacity;
- continuous involvement of ATM stakeholders in the planning process;
- basing the development and implementation planning on the rigorous application of Cost-Benefit Analysis using commonly agreed analysis principles and data. Implementation of future airborne capabilities should be based on benefit driven incentives for the users rather than merely mandating;
- ensuring the interoperability of the European ATM network with adjacent areas, allowing homogeneous traffic flows and non-discriminatory access of aircraft operators based outside the ECAC area. ATM technologies and procedures must adhere to future ICAO Standards and Recommended practices. Users encourage European States to pro-actively contribute to the development of ICAO Standards for future CNS/ATM systems;
- delivery of various levels of service as requested by individual users. European ATM must be flexible enough to allow operation ranging from certain kinds of VFR traffic requiring no service at all up to aircraft operations requiring full ATM services. Additionally, European ATM must cater for different levels of capability of airborne equipment;
- supporting the aircraft operator's responsibility for the conduct of safe and efficient flight operations. This implies that the final decision on the acceptance of clearances or planned trajectories remains with the aircraft operator and that ATM has no access to flight control systems, e.g. Flight Management Systems, without active control by the flight crew;
- supporting flexible, dynamic adjustment of aircraft trajectories to the optimum rather than inflexible deterministic pre-planning of trajectories in order to enhance the efficiency of flight operations;

- improved availability and increased accuracy of meteorological data required for flight and trajectory planning;
- insuring handling of specific defence flights subject to various constraints.

The February 1998 workshop largely confirmed the stakeholder needs recorded some three years earlier. The main messages were the following:

- the future ATM system had to be based on a benefit-driven approach supported by clear business cases and must incorporate measurable performance targets;
- safety was paramount and the need to improve safety levels in the face of increasing demand must be emphasised;
- environmental gains, together with any associated environmental related penalties, must be clearly spelt out in the Strategy;
- the right of access to airspace for all users must be a central objective;
- greater emphasis had to be placed on the need to increase airport capacity and airport and en-route capacity gains had to be balanced and remain in step if the full benefits of future investments were to be realised;
- collaborative decision making based on improved planning procedures and information management was an important key to a more efficient, flexible and effective ATM network and needed to be applied at both the strategic and tactical levels;
- the human, both in the air and on the ground, would remain an essential part of the ATM network for the foreseeable future and this had to be taken into account in the early design stages of the enabling systems and infrastructure;
- increasing the productivity of the air traffic controllers through the extensive use of computer support tools was a critical factor in finding the extra capacity needed;
- airspace management measures needed to be more ambitious and applied by all States. A ‘Schengen’ approach was needed;
- ATFM had to incorporate flexible capacity management and include consideration of gate-to-gate operations;
- Communications, Navigation and Surveillance systems had to be developed within a single coherent framework to more aggressive timescales;
- the role of essential services such as meteorology and AIS had to be recognised and statements concerning national defence needs and military requirements strengthened and expanded;
- implementation management mechanisms had to be clearly defined and rigorously enforced;
- R & D activities needed to support the strategy had to be identified and prioritised.

1. INTRODUCTION

1.1 Background and History of EATCHIP Stakeholder Consultation

The *ECAC En-route Strategy of the 1990's* laid the foundation for the *European ATC Harmonisation and Integration Programme* (EATCHIP):

- Phase I: appraisal and evaluation of ATM in Europe, completed by mid-1991;
- Phase II: development of the EATCHIP Programme, completed by mid-1993;
- Phase III: acquisition and implementation, aiming at *harmonisation* of ATM, completed in 1998;
- Phase IV: planning and implementation of the future European ATM network, aiming at *integration* of ATM. This activity started in parallel with earlier phases and is further detailed below.

Following MATSE/3 in 1992, work for the definition of a concept for future European ATM was undertaken. It considered an evolutionary transition towards the future European ATM network and, around the year 2015, achievement of full operational capability, i.e. marking the completion of the transition towards the *Target Concept*.

From the outset, the development of the future European ATM network was approached in a top-down and customer/user oriented fashion.

The EUROCONTROL Agency started the process internally in 1993 with the development of an initial high level vision of where ATM in Europe should be in the year 2015. After extensive review by stakeholder representatives in the EATCHIP organisation (EATCHIP Teams, Liaison Officers and Project Board), this was published as the *Mission, Objectives and Strategy Document* (MOSD) early 1995.

Around the same time, the consultation was widened: EUROCONTROL and the European Commission sent an open invitation to all segments of the aviation community to attend a *User Requirements Workshop*: 150 delegates gathered for three days in Brussels in September of 1994, to discuss their future needs. The results of this workshop were processed by a smaller group of aviation community representatives. This culminated in the publication of the first edition of the *User Requirements Document* (URD) in September of 1995.

This URD was subsequently analysed as part of an EC 4th Framework Programme study (ADORA).

The knowledge acquired at that stage was used to develop the *Target Concept* for the year 2015, published in the first edition of the *Operational Concept Document* (OCD) in March 1997. This was again conducted in an open and collaborative spirit: the concept was developed by a task force comprising representatives from the airspace users, service providers and other segments of the aviation community. For consultation purposes, the document was given wide circulation in the aviation industry during its final drafting stages. Edition 1.0 of the OCD also contained first ideas about the sequence of improvements making up the *Road Map* for transition.

In order to tackle the challenges of the 21st century, new ideas were also being progressed on the institutional front. This led to the adoption of a new ECAC ATM Institutional Strategy by Transport Ministers in 1997, and a Revised Convention for EUROCONTROL. At the same time, Ministers requested a proposal for a comprehensive, gate-to-gate orientated, ATM strategy for the years 2000+ to be considered at their next meeting in 1999.

Meanwhile, the ATM scene had continued to evolve in the years since the inception of the EATCHIP programme. In 1996 EUROCONTROL management started a process of *EATCHIP Alignment* which in particular led to the following results:

- Confirmation of the need for a *gate-to-gate* approach of future ATM and definition of what this term implies.
- Precursor activity for the development of the *ATM Strategy for 2000+*.
- Proposals to improve the EATCHIP programme management to better meet user needs, including a segmentation model of ATM stakeholders.

As an interim measure, an initial version of the Strategy was developed by an internal EUROCONTROL team as a vehicle for consultation with the aviation community about how ATM in Europe should develop into the next century. In consultation with the ECAC DGCAs, the DG EUROCONTROL then set up a Strategy Board, drawn from the senior management representing the aviation stakeholders, and professional and international organisations, to continue the development of the Strategy proposal for Ministers.

As part of the continuing consultation process, EUROCONTROL held an *ATM 2000+ Workshop* in Luxemburg in early 1998 to explain the Strategy and Target Concept proposals and obtain feedback from the wider aviation community. The results of that feedback have been incorporated in later editions of the Strategy and Concept documents.

The above history of events demonstrates that EATCHIP stakeholder consultation is an ongoing process which permeates the development of ATM in Europe at all levels, and is in no way limited to the documentation of Stakeholder Needs in a single document, i.e. the URD.

1.2 Purpose of this Document

The planning process being introduced to support the development of uniform European Air Traffic Management implies regular updates of the basic documentation containing the data from which the plans are derived. With the planned adoption of the *ATM Strategy for 2000+* by the ECAC Transport Ministers in 1999, it is now appropriate to issue a new version of related documents such as the URD.

Many of the messages contained in URD 1.0 have already found their way into today's thinking about the future of ATM in Europe, and are reflected in follow-on documents, notably the OCD and the ATM Strategy for 2000+.

When faced with the task of producing an up-to-date version of the URD, an approach was sought which would bring added value to the first version. The aims are:

- to address the main shortcoming of the first edition: "that the list of stakeholder needs is not *directly* useable for more detailed work";
- to keep a connection (traceability) between the two editions;
- to provide the EATCHIP stakeholders with an indication of how the contents of URD 1.0 have been taken into account;
- to keep those stakeholder need statements which (still) need to be addressed by future work documented and thus available to the EATCHIP participants.

For these reasons, it was decided to keep the text of the original URD Volume 2 statements in an unabridged, unmodified form, and to bring added value by:

- changing the titles of stakeholder needs to better reflect the underlying content
- adding the key messages of the 1998 user consultation workshop
- adding traceability, i.e. showing how these statements are currently being (or need to be) taken into account by EATCHIP. This is done by cross-referencing the Stakeholder Needs to more recent work: elements of the ATM Strategy for 2000+, with subsequent traceability to the Target Concept described in the Operational Concept Document (OCD).

2. STRUCTURE OF THE DOCUMENT

2.1 Overview of Contents

For practical reasons, the document is published in several volumes:

VOLUME 1

Section 1 discusses background and history of EATCHIP Stakeholder Consultation. It also explains the purpose of the URD.

Section 2 shows how the document is structured, and explains how configuration management and traceability is handled.

Section 3 provides a summary of the stakeholder needs as they were recorded during 1994. This part of the document is identical to the material published in sections 2-7 of URD edition 1.0 Volume 1.

Section 4 summarises the results from the ATM 2000+ Workshop held in Luxemburg during February 1998. The material is extracted from the workshop proceedings.

Section 5 points interested readers to other work in the area of ATM stakeholder needs.

VOLUME 2

Volume 2 is a reference document, permitting access to information in a variety of ways. The material presented here contains detailed statements, which are appropriately configuration controlled and linked to other material with a variety of traceability relationships.

Chapter 1 introduces the subject by briefly describing the official EATCHIP stakeholder segmentation model (developed during the EATCHIP Alignment & Adaptation Process, documented in the EATCHIP Management Handbook).

Chapter 2 lists the Stakeholder Needs in terms of Air Navigation Services. The chapter is included for the convenience of the reader. It is basically the same presentation as in edition 1.0 of the URD (Volume 2).

Chapter 3 groups the Stakeholder Needs by 'Theme'; a categorisation which is largely based on the 'Special Subjects' requirement classification of edition 1.0 (see ed. 1.0 Volume 2, pages B-6 and B-7). The taxonomy of 'themes' includes issues such as safety, capacity, flexibility, integration etc. Notice that this classification is closely related to (but wider in scope than) the strategic principles and objectives contained in the ATM Strategy for 2000+.

Chapter 4: Whereas the previous chapters contain only references to *titles* (summaries) of Stakeholder Needs, Chapter 4 is a **dictionary** containing the *complete text* and *traceability relationships* of all Stakeholder Needs, alphabetically ordered by title.

2.2 How Configuration Management and Traceability is handled

The contents of URD Volume 2 are stored in a general purpose 'knowledge base', which serves to keep track of large quantities of information entities and complex webs of information interrelationships. At present, this 'Strategy, Concept & System Knowledge Base (edition 2.01)' contains approximately 850 information entities interconnected by a traceability web of over 3000 relationships. The data is entered, analysed and manipulated via a tool called *Entity Relationship Analysis Tool* (ERAT), developed within EUROCONTROL. Advanced reporting capabilities allow to analyse these relationship webs and output the result in user friendly (document-like) formats such as URD Volume 2, or HTML format with hypertext links.

The selection and presentation of information in Volume 2 has been chosen to suit the needs of the URD best. However differently structured reports based on the same data can easily be provided upon request.

3. THE USER REQUIREMENTS WORKSHOP HELD IN 1994

This section presents a summary of the ATM stakeholder inputs gathered at the User Requirements Workshop organised jointly by EUROCONTROL and the European Commission DG VII (Transport) in September 1994, and attended by some 150 delegates.

The workshop participants particularly emphasized the the need for:

- developing European ATM as a network for “gate-to-gate” operation, i.e. covering all phases of a flight. This implies a strong consideration of measures to enhance airport capacity;
- continuous involvement of ATM stakeholders in the planning process;
- basing the development and implementation planning on the rigorous application of Cost-Benefit Analysis using commonly agreed analysis principles and data. Implementation of future airborne capabilities should be based on benefit driven incentives for the users rather than merely mandating;
- ensuring the interoperability of the European ATM network with adjacent areas, allowing homogeneous traffic flows and non-discriminatory access of aircraft operators based outside the ECAC area. ATM technologies and procedures must adhere to future ICAO Standards and Recommended practices. Users encourage European States to pro-actively contribute to the development of ICAO Standards for future CNS/ATM systems;
- delivery of various levels of service as requested by individual users. European ATM must be flexible enough to allow operation ranging from certain kinds of VFR traffic requiring no service at all up to aircraft operations requiring full ATM services. Additionally, European ATM must cater for different levels of capability of airborne equipment;
- supporting the aircraft operator’s responsibility for the conduct of safe and efficient flight operations. This implies that the final decision on the acceptance of clearances or planned trajectories remains with the aircraft operator and that ATM has no access to flight control systems, e.g. Flight Management Systems, without active control by the flight crew;
- supporting flexible, dynamic adjustment of aircraft trajectories to the optimum rather than inflexible deterministic pre-planning of trajectories in order to enhance the efficiency of flight operations;
- improved availability and increased accuracy of meteorological data required for flight and trajectory planning;
- insuring handling of specific defence flights subject to various constraints.

Even though most requirements summarised here focus on Air Traffic Services, it should be noted that other aspects of Air Traffic Management, i.e. Air Traffic Flow Management, Airspace Management, as well as the components of Communications, Navigation and Surveillance are addressed by the ATM stakeholders. In particular, the military expressed the need to maintain compatibility with defence and military air traffic systems of the various Member States.

The aviation industry appreciated the process of the development of the User Requirements Document. ATM stakeholders stressed the need for further iterations of the URD. Further work is required particularly to develop the next level of detail and to establish a system to measure the fulfilment of the stakeholder needs in the development of European ATM. Since the airspace users only have limited resources available for this process, the support from the EUROCONTROL Agency, the European Union and other parties is highly appreciated.

In summary, the requirements expressed by European airspace users in this document underline the need for the development of an integrated European Air Traffic Management network taking advantage of future technologies and more efficient procedures for ATM services. The qualitative requirements expressed in this document in combination with the expected traffic growth in Europe in the long term will require significant changes to ATM concepts, procedures and systems, beyond the harmonisation objectives of EATCHIP Phase III.

3.1 Principal Needs

3.1.1 Safety

All ATM stakeholders consider flight safety as paramount. It is the responsibility of ATM to ensure that in each phase of flight the current high safety levels are at least maintained. Means to assess and monitor flight safety levels need to be put in place.

Airspace users suggest that a method for monitoring system loading, with a safety net arrangement which warns ATC management when the system is nearing theoretical capacity, be implemented. This would enable ATM providers to take action to avoid overload. The underlying principle should be prevention rather than cure.

Safety improvements at major airports in low visibility conditions are expected by aircraft operators. European ATM should also take the capabilities of airborne collision avoidance systems into account to serve as a last resort and independent safety net.

Quality assurance of source data (navigation, clearances, etc.) will become a real flight safety issue for European ATM and needs addressing with the increasing use of automation and data link applications.

For **commercial air transport** (IFR operators) using advanced automated navigation systems, ATM needs to perform a continuous monitoring of 4D flight profiles in order to promptly detect involuntary deviations and/or emergency cases.

Flight safety implications of potential reliance by **weather service providers** on meteorological data for accuracy trajectory predictions need to be assessed.

3.1.2 Resilience to Service Disruption - Contingency Planning

The ATM network's resilience to service disruption must be at least the same as today. ATM should in addition strike the right balance between robustness and fallback procedures. European ATM is expected to enable the parties involved (pilots and controllers) to have, at all times, precise knowledge of the nature, probability and extent of possible contingencies and of the latest applicable contingency plans.

The design of European ATM network should produce no ATM overload, subject to proper cost considerations.

3.1.3 Capacity

All ATM stakeholders state that the ATM network is expected to always adjust its capacity to the demand subject to appropriate cost effectiveness criteria for both aircraft operators and ATM providers. The basic requirement expressed by the users concerning strategic demand/capacity balancing is that there should be no pre-planned balancing of demand imposed by European ATM, i.e. strategic capacity allocation must be based on the demand.

Airspace users recognise that the runway capacity will still be a limiting factor in the next decades. New technologies will have to increase the airport capacity and the airspace capacity to match that demand. The ATM network should not be the limiting factor.

3.1.4 Efficiency

The aspect of efficiency addressed here by all users is the operational and economic efficiency of their flight operations.

Airspace users measure flight efficiency from gate to gate. Hence European ATM must, in the provision of its services, deal with flights as a whole instead of treating each flight phase separately. According to some airspace users, an integrated service might even extend further than the block-to-block definition, i. e., starting with pre-tactical flight planning and ending after completion of post-flight activities (e.g., including cost recovery, incident and performance analysis).

Aircraft operators want to fly the most cost efficient or optimum trajectory as determined by themselves alone. European ATM is required not to impose significant irregularities and delays on flight operations. In order to maintain the efficiency of commercial air transport network operations (e.g. hub-and-spoke), those airspace users require on one hand a particularly high degree of regularity and punctuality at hub airports which need to be supported by the European ATM network.

On the other hand, European ATM is required to be flexible enough to cater for short term changes of departure times as determined by the aircraft operators in order to allow the connectivity of flights in case of delayed arrivals.

European ATM must enable military users to carry out their missions; in particular by maintaining compatibility of the two types of air traffic and, if possible, by pursuing an harmonisation in line with the evolution of military systems.

3.1.5 Flexibility

Flexibility means the following to the individual airspace user:

- never to be locked into a single course of action. In those cases where the ATM network does not support the users' preferences, they want to be informed about the available alternatives and make their own choices
- never to be locked into a pre-planned course of action. If users decide that their original approved plan (trajectory) needs to be changed, for whatever reason, ATM should support that request.

European ATM should support flexible, dynamic adjustment of aircraft trajectories to the optimum rather than inflexible deterministic pre-planning of trajectories in order to enhance the efficiency of flight operations.

Collective flexibility refers to the right of the European airspace user community to grow, while maintaining or extending its existing diversity of users, each with their own operating characteristics and needs.

The users' desire for flexibility puts a number of flexibility requirements on European ATM with respect to:

- users with different operating (mission) requirements
- needs which are location specific (area differences)
- users with different equipment (aircraft, avionics)
- flight scheduling process of the users

All airspace users want a flexible use of all airspace, including Temporary Segregated Airspace (TSAs to be active only when actually required). All IFR

users want availability of entry to airspace for controlled flights. Users reaffirm their position against airspace segregation. They wish an ATM network and an operational concept in which shared use of all airspace for different user groups is safely possible. On one hand, the sovereignty of States over their own airspace should not hinder a flexible, optimised use of airspace according to the airspace users' operational needs. On the other hand, European ATM should neither inhibit nor require the exercise of the sovereignty of the States over their own airspace.

3.1.6 Cost Effectiveness

All ATM stakeholders demand "value for money". European ATM has to be cost efficient because the cost of providing the services including related investments for implementation are recovered through user charges. This implies that firstly, the cost associated with the services of ATM must be affordable for the user community as a whole. Furthermore, however, users strongly require that the specified, affordable set of services, with certain associated and agreed quality of service levels is provided by ATM at minimum cost.

Existing ICAO guidelines regarding user charge policies and principles should be followed.

All users want total visibility on costs and charging (cost recovery) mechanisms regarding ATM system development and operation expenditures. Constant monitoring of ATM services costs and quality of service ("benchmarking") delivered to the client is needed to ensure the cost effective provision of such services.

European ATM should be developed using cost benefit principles for the entire ECAC area instead of for individual States. All users agree that a common cost benefit methodology is essential. Users will also carry out their own individual assessments before committing themselves to investments.

The partial disruption of ATM services should not have an adverse impact on flight safety. A balanced approach within ATM development based on cost benefit considerations is required to determine the redundancies necessary for non-safety critical services whose disruption would have an adverse effect on the users' business.

In addition users stress the optional character of the use of ATM services and corresponding avionics investments. Such services should in principle not be compulsory but basically offered and be made available to all categories of users whenever they need them. When, in other words, a user prefers not to use ATM services, or wants to use only a limited set thereof, and when there is no requirement to do so, he should be free to refrain from using ATM services.

3.1.7 Uniformity

The European ATM network must ensure the interoperability with adjacent areas, allowing homogeneous traffic flows and non-discriminatory access of aircraft operators based outside the ECAC area, provided mandatory equipment and avionics capability standards are complied with. For the establishment of mandatory avionics capability standards, compliance with international standards laid down by ICAO is essential. Users encourage European States to pro-actively contribute to the development of ICAO Standards for future CNS/ATM systems. Requirements imposed by ATM on aircraft operators must be in line with the principles of the Chicago Convention and the World Trade Organisation (former GATT) in order not to build artificial barriers for air transport and trade.

European ATM should aim to harmonise the quality of service within ECAC and adjacent airspace in order to allow smooth transition of flights entering and exiting the ECAC airspace.

All airspace users require that Europe reaches a high degree of harmonisation and a uniform application of airspace rules, including standard separation minima throughout the ECAC area. Nevertheless provisions may have to be made to enable certain military aircraft operations within an harmonised airspace.

It is necessary to initiate actions on the institutional and political fronts to adopt measures in order to provide an air traffic service which is seamless from the users' point of view. There should be a clear distinction between the responsibilities for the functions to be performed by governments and management of the ATM network.

Users want a body or somebody taking responsibility for common, correct and complete information on airports and navigation aids (e.g., AIS) within the ECAC area. This requirement also applies to meteorological and aircraft position data. The user is not advocating a centralised data base but is mainly concerned with the availability of correct data and the consistency between the ground and air (e.g., FMS) components of the ATM network.

Individual State authorities need to closely co-ordinate efforts on the certification process of airborne and ground equipment in order to achieve interoperability between the ground ATM network ("groundworthiness") and the avionics, especially in the datalink environment.

3.1.8 Civil/Military Interface

All military flights should be able to be carried out. The concept of flexible use of airspace will allow the optimisation of resources.

European ATM must cater for different standards of military and civil equipment (e.g., minimum navigation requirements). Due to the military flexibility requirement, certain initial overbooking of airspace on the pre-

tactical level will occur. However, on a tactical level, real time coordination is needed to ensure that all unused airspace is made available at the earliest possible moment (flexible use of airspace). As a result there is a need for further automation of the airspace management interface between civil and military centres. In particular, civil airspace users consider that data exchange between military and civilian functions should not impose constraints on them.

The military have a need for airspace to support, among other operations, their training activities.

The required interoperability between the European ATM network and air defence and military control systems will follow from the provision of unrestricted, timely and accurate exchange of:

- pre-tactical and tactical airspace management information including the real time airspace requirements for military activities
- flight data, including air tracks and flight plan data
- airfield status information
- tactical control of aircraft, using common hand-over procedures
- position data based on a common datum (WGS-84).

3.1.9 Security

The significantly increased use of ground-ground and air-ground data communications between ATM and its users requires rigorous security measures to prevent unauthorised access to communication systems and the data exchanged via the communication networks and stored in data banks. Data security is needed to protect flight safety, commercial and military interests. The users stress that even in an advanced system, they see a role for the human being (pilot/controller) as the last check on security.

The European ATM network shall protect itself against threats and risks (physical, environmental, electronic, etc.).

3.1.10 Environment

With regard to the impact of air traffic on the environment, the airspace users state that the reduction of noise and gaseous emissions is primarily their own responsibility vis-à-vis national and international environmental standards and regulatory bodies. Of all the techniques they use to achieve that goal, the one that ATM is concerned with is the user preferred trajectory request. The main environmental role of ATM is to provide adequate capacity, enabling the users to fly those requested trajectories. In case of operational constraints (due to traffic conditions), ATM is expected to choose trade-offs which organise the total traffic flow in such a way that the additional environmental impact due to congestion is kept to a minimum.

Aerodrome operators require that during the design, development and implementation of ATM the following requirements be taken into account:

- respect environmental agreements communicated by the airport authorities without compromising flight safety
- establish ATM procedures which reduce the environmental impact of air traffic.

3.1.11 Principles of Treatment

Equitable treatment of all airspace users is essential. The users wish to see the “first come first served” principle to be maintained in the future, including the pre-flight allocation of airspace and trajectories. However they accept deviations from this rule in order to facilitate enhanced traffic flows at certain airports on the basis of agreements with the operators concerned.

ATM should handle all types of aircraft with different levels of performance and avionics capabilities in an equitable manner.

ATM should take into account the capabilities of sophisticated CNS/ATM avionics by offering appropriate incentives and benefits.

ATM shall avoid introducing mandatory airborne capabilities which are not in line with global standards or discriminate against non-ECAC operators.

European ATM must maintain compatibility with defence systems of Member States.

ATM must insure the handling of specific defence flights subject to various constraints.

The provision of airport access to all types of airspace users is requested, especially by **general aviation** users who are not permitted in some airports, although it is realised that this is a matter of airport policy rather than an ATC responsibility.

3.1.12 Stakeholder Participation

ATM stakeholders desire a continuous involvement in the planning process of ATM.

3.1.13 Role of Human in ATM

The ATM stakeholders require the human to remain an essential part of the aviation system. Both in the aircraft and on the ground, the role of the human should be one of essentially monitoring and supervision. The controller should be responsible for maintaining separation. During emergencies or contingencies the pilot requires to have access to a human being on the ground for conflict resolution and emergency handling. Users accept the

ICAO defined roles and responsibilities of the controller and the pilot, while recognising that those can be modified in the future.

The aspects of legal liability and responsibility for incidents must be clarified before more automation is added. If European ATM relies more on automated planning mechanisms for strategic and tactical planning purposes, there is a requirement for that system to handle in-flight contingencies at the tactical level. The human -- controller, pilot, or airline operations controller -- needs to have the authority and means to deal with the contingency. Steps will have to be taken to ensure that the design and operation of ATM is such that when emergencies occur or equipment fails, both pilot and controller will be sufficiently aware of the traffic situation to enable them to effect a recovery.

The airspace user requires a co-operative system design which takes into account the cockpit human factors.

3.1.14 Transition Issues

ATM stakeholders should be involved in the development process and transition at multiple levels. Milestones need to be identified that clearly bring benefits at each stage of implementation of ATM. As part of that process, cost benefit analyses need to be conducted at regular intervals to indicate what benefits will (should) be available and when.

Pre-operational field trials should be encouraged on local, national and international levels to the benefit of European ATM. Retrofit, lead times and pre-notification are essential factors to consider in ATM implementation to allow, among other things, training and familiarisation phases in the transition schedule for both ATC and airspace user personnel. The users also see a need to provide a “pull” strategy to provide the incentive for the shortest transition period possible in order to minimise the simultaneous support of existing and new functionality.

Some **General Aviation** and **Aerial Work** operators ask for proper user guidance, public funding and professional implementation management to enable the accelerated standardisation and certification of available advanced CNS technologies.

A mechanism for the resolution of conflicts of interest, when there are clearly identified conflicting requirements, must be established for transition planning and coordination.

ATM stakeholders favour a stepwise introduction of automation, rather than a sudden change, due to the need for human (controllers and flight crew) acceptance of and trust in new systems.

No particular skills nor ratings additional to those globally standardised must be required to operate in the European ATM environment.

Weather service providers state that careful consideration has to be given to the implementation order for ATM and meteorological services due to the close interdependence of ATM and meteorological information functions.

3.2 Pre-Flight Operations

3.2.1 Pre-Flight Communication Services

The principle of eliminating excessive routine voice communications should apply to all flight phases in the ground/ground and air/ground communications ("silent cockpit"). The pilot wants as few frequency changes as possible and expects the ground ATC system to have total knowledge of his pre-departure and departure plans and requests.

3.2.2 Pre-Flight Environment Information Services

Airspace users have a basic requirement for up-to-date Met and AIS information prior to any flight operation. European ATM should provide automated information facilities for briefing and flight purposes.

Some users also expressed the following additional requirement to be considered by ATM, i.e., provide availability of self-briefing at all aerodromes and from home via personal computer through an open network, in order to obtain information on airspace occupancy (slots), AIP, weather, NOTAM and flight plan entering.

For strategic flight planning (months up to day minus two) purposes, timely, accurate, complete and up-to-date information concerning all components of the Air Navigation Services need to be made available to aircraft operators. Such information must be available in standardised formats to allow automatic processing, storage and retrieval. This requirement also applies to the pre-tactical (day minus one) and tactical (same day) flight planning phases.

As regards the AIP publication and its contents for pre-flight planning activities, users express a need to:

- review the AIP to standardise the system information format
- apply configuration management to ensure the accuracy and timeliness of the data
- integrate all AIP databases
- ensure the integrity of the information stored in the databases

3.2.3 Pre-Flight Meteorological Services

A requirement is expressed by all airspace users to ATM to examine who has responsibility for the certification of Met equipment, personnel and Met products for aeronautical services.

Met information is needed for the strategic flight planning phase. Airspace users require:

- specific Met forecasts according to special interest group's needs
- access to such weather data by all airspace users
- access to statistical information on upper winds and temperatures throughout the airspace, and possibly on cloud, turbulence, etc.
- access to statistical information on surface (aerodrome) meteorological conditions (including runway conditions of rain, snow, ice, etc.).

Airspace users require during the pre-tactical flight planning phase the following Met information:

- forecasts up to 96 hours ahead, for upper winds and temperatures, aerodrome winds and temperatures for relevant aerodromes, significant weather phenomena including volcanic ash
- forecasts up to 96 hours ahead for weather conditions which are significant for certain special nature VFR flights (e.g., aerial work, sporting and recreational aviation).

Low performance aircraft (e.g., unable to fly above the weather or having poor navigation capabilities or no de-icing) operated by **general aviation** and/or **aerial work** operators need special Met information to compensate for this handicap:

- special customised forecasts are needed for sporting purposes:
- forecasts to enable safe cross-country flying for balloons, gliders, micro-lights, etc.
- wind forecasts for parachute dropping
- forecasting of mountain wave conditions for altitude flights
- daily forecasts for competitions

During the tactical flight planning phase, aircraft operators require continuous, accurate and complete observations on the present weather, for the interest and/or responsibility areas, including the departure, arrival and alternate aerodromes; short term prognosis based upon real time information; information obtained from in-flight to be integrated immediately, increased frequency at which weather models are run and updated taking into account airborne data.

3.2.4 Pre-Flight ATM Services

For **short haul** and **regional** operations there is a need for ATM to make them wait on the ground rather than in the air in case of weather contingencies and to be treated fairly with respect to arriving long haul aircraft

in the air while they have not taken off yet. Once given the takeoff clearance they should be able to fly directly to the destination.

3.2.5 Airspace Management

In the strategic flight planning phase, airspace users express the requirements:

- to implement a basic route structure flexible enough to satisfy operators' needs through the continuous optimisation of the RNAV routes. Users must have the opportunity to capitalise upon new technological developments (e.g., GPS, RNAV)
- to establish means for a two-way dialogue between Airspace Management services and the users/operators
- for transparency of airspace division to the users (division between upper/lower airspace, etc.)

In the pre-tactical flight planning phase, there is a requirement:

- for the same needs as defined in the strategic flight planning phase
- for the operator to know at any time the airspace available for planning processes in order to define the best possible route
- for the user to have the freedom to optimise routes according to the most appropriate criteria for the effective operation of their business.

In the strategic flight planning phase, **General Aviation** users express the requirement to have access to the same systems as airline operators.

The reduction of unnecessary low level controlled airspace is sought by the **General Aviation** and **Aerial Work** (including helicopter) operators who see the existing classification of airspace surrounding several airports as a major hindrance to the development of VFR operations. Sporting and recreational aviation (in particular the gliding community for cross-country flights) hopes to see a maximum of airspace classified as E, F or G, and requests a maximum flexibility in airspace use, especially between the civil and military agencies.

3.2.6 Air Traffic Flow Management

The capacity of the infrastructure must be sufficient to permit all airspace users a high degree of freedom and flexibility for planning services to meet the air traffic demand.

Airspace users said "no" to flow management restrictions as a routine procedure in the design and operation of the European ATM network.

Common ATFM requirements for all phases of pre-flight include:

- the flexibility of ATM to cope with unforeseen short term changes in demand or partial failures whilst ensuring that the repercussions for all airspace users remain acceptable
- the ability for operators to have maximum freedom including the possibility to exchange slots between flights if required
- a direct two-way dialogue within ATM (preferably machine to machine)
- a sufficient operational response and subsequent updates from ATM slot allocation that meet the users operational requirements
- the freeing of the operator from the limitations of a Traffic Orientation Scheme.

The adaptation of ATFM systems to operational needs of air defence flights must be guaranteed in all circumstances (priorities, missions limited to national territory, etc.)

3.2.7 Flight Planning Requirements

Flight plan requirements for all phases of pre-flight include:

- an exemption of the obligation to file a flight plan, for all VFR flights (including international VFR flights) within the ECAC area which do not require clearances. However, in some cases, i.e. for flights over remote or mountainous areas, there may be a need to file a flight plan for search and rescue purposes
- the requirement to send flight plans to a single address for dissemination as appropriate
- the availability and flexibility to formulate and modify flight plans as close to the estimated off block time (EOBT) as possible
- an enhanced Planned Flight Data submission which would obviate the need for strategic flight planning (RPL)
- improved communications means and simplified procedures for completing flight plans

In times of exceptional circumstances, the CFMU should notify the ATM stakeholders of the restrictions that are foreseen during the pre-tactical flight planning phase.

If restrictions are confirmed, the CFMU should offer alternative solutions to minimise the deviation from the original requirement during the tactical flight planning phase.

Significant en-route weather phenomena, e.g., CAT, widespread embedded Cb, should be taken into account for ATM route planning on the day.

3.3 Flight Operations

3.3.1 ATC Services

To make best use of dynamic management of airspace, aircraft operators must have knowledge of the availability of airspace in real time.

Some airspace users conducting General Air Traffic operations express the need for European ATM to accommodate early arrival of flights (arrival flexibility).

3.3.2 Communications Services

Some Commercial air transport users express the desire to implement the 4D profile communication capability via **datalink** as early as possible. Strict emulation of voice procedures by datalink is not deemed useful or acceptable by the airspace users. They advocate a concomitant change of procedures to adapt to new capabilities.

As a major element of world-wide harmonisation of aviation rules and procedures, all voice communications should be made in **English**. English is the ICAO aviation standard language for aircraft operations and should be used by all pilots involved in commercial air transport and at large airports so that pilots are aware of the surrounding traffic situation.

Aircraft operators want European ATM to ensure that the volume of the air-ground data which has to be transmitted to aircraft be reduced to the effective operational minimum, for reasons of cost and technology.

The airspace users, in general, are willing to communicate to ATM their position, estimates (e.g., ETD, ETA, crossing of a fix) and intention.

GA and AW operators strongly require the protection of emergency frequencies.

3.3.3 Navigation Services

Users expect the Global Navigation Satellite System (GNSS) to provide the future navigation infrastructure. Navigation shall be based on the application of ICAO's RNP concept allowing a high degree of flexibility for aircraft operators with regard to navigational equipment used. A continuous development of RNAV-routes is expected by the users in order to optimise the route structure.

3.3.4 Surveillance Services

Airspace Users want a surveillance service compatible with global standards. Surveillance coverage should exist throughout the complete ECAC area.

As much as possible, the pilot in command and the controller should have independent situational awareness information (for flight safety reasons).

In addition to all requirements expressed for an Advanced Surface Movement Guidance and Control System (A-SMGCS) regarding navigation, the corresponding surveillance capabilities need to be developed.

3.3.5 FIS Services

Airspace users should be provided with the necessary meteorological information during flight, e.g., SIGMET or aerodrome METARS and TAFs. If required by the operators, these should be available through data link. In order to provide the necessary accuracy, aircraft flight management systems may require an update of the upper air (wind and temperature) data. In this case the data should be in a form suitable for direct loading into the aircraft's FMS.

Serviceability status of navigation aids and information on changes in condition of aerodromes and associated facilities are other FIS requirements. Whether European ATM can or will provide this type of aeronautical information, and by which means, remains an open question.

Some **General Aviation** users want the capability of having weather data information (e.g., VOLMET, SIGMET) transmitted from the ground to on-board weather display equipment (moving maps). VOLMET and SIGMET information should be made available on voice for VFR pilots.

3.3.6 Terminal Area, Aerodrome and Ground Control Services

The main goal of an A-SMGCS is to provide all "control authorities" (general term to refer to all the parts concerned with the airport traffic movement) with positive situation awareness of traffic evolving in the areas used for aircraft movement, the runway strip and any designated protected areas, as well as provide guidance to that traffic, be they aircraft and/or vehicles.

Aircraft operators consider the integration of A-SMGCS and ATM as necessary to ensure the efficient management of airport operations through a common flow of information exchanges. The current SMGCS operations based on the principle of "see and be seen" need to be improved in order to handle great numbers of traffic navigating in complex airport layouts and maintain runway capacity in difficult weather situations especially in conditions of low visibility when visual separation becomes impractical.

In order to improve the fluidity of the arriving and departing air traffic, the aircraft operators feel that it is necessary to provide new standardised ATM procedures, based on ICAO provisions, adapted to the different performance and equipment of the different types of aircraft, taking into consideration different runway configurations (e.g., crossing runway operations) and making special provisions for helicopters and STOL aircraft, etc.

Airspace users express the requirement that European ATM has to maintain flow continuity in all weather conditions whose frequency of occurrence is significantly affecting the regularity of operations.

3.3.7 Post-Flight Services

For incident and accident investigation purposes the ATM network must provide mechanisms to record and make available any data that is necessary to reconstruct the air traffic situation and the sequence of events, based on a common time reference. Data is to be considered confidential and reports are to be distributed to authorised parties only. ATM should report all incidents that are sufficiently serious for later investigation by a suitable body.

3.4 Airports

Aerodrome operators and airspace users want ATM to optimise departure and arrival sequencing and taxi routing to avoid wasting theoretical airport capacity.

The design, development and implementation of ATM must consider the following requirements:

- establish procedures and standards which permit the exchange of data between ATM and airports
- ATN to integrate all airport relevant information (incoming and outgoing) via different sources using a unique format
- make available data relevant to airport operations from the airborne system through ATM

In support of strategic and pre-tactical airport operations, aerodrome operators require that ATM provides flexibility to meet sudden changes in airport operations and ensure close coordination between the airport and the CFMU function to increase the accuracy of departure times. Aerodrome operators express the need for future ATM to transmit to them via datalink or other efficient means information on departing and arriving traffic (e.g., departure out block slot, departure, taxi clearances, runway conditions, estimated time of arrival). Volume 2 contains a more exhaustive listing of requested data elements.

European ATM will have to adapt to military aerodromes that handle General Air Traffic only occasionally and will therefore operate under conditions different from applicable standard procedures.

Aerodrome operators want to co-ordinate with ATM (CFMU) the airport capacity and schedule (through e.g., Schedule Committees) so that ATM can provide unconstrained airspace capacity, which balanced with the airport schedule, meets the traffic demand without incurring delays.

Aerodrome operators and airspace users require that ATM must be able to cope with unexpected changes in airport capacity due to weather, airport/ATC equipment failure or accident on airport. ATM must manage unscheduled disruptions with the minimum impact on the standards of service and capacity provided.

3.5 Meteorology

Both Meteorological service providers and their users, which also includes ATC providers, emphasise the need for a comprehensive, easily accessible Meteorological service infrastructure in Europe, to cater for all types of airspace users.

A distinction is made in the expression of requirements between the Met data provided for general assistance to aviation in the conduct of flight, and for making ATM work properly, i.e. for calculating trajectory data for ATM purposes. A supplementary infrastructure (outside and inside the European ATM network) may be necessary to cater for the former while the ATM network should provide enhanced capabilities regarding the latter aspect. Improvements to the Met service are an associated but parallel activity to the planning and development of European ATM.

Due to the complex interactions between the (numerous) parties involved in the collection, processing, distribution and use of weather data and products (nowcasts and forecasts), the following requirements are formulated in a layout which clearly identifies the party which expresses the need and the entity to which the requirement is addressed. Some more general requirements common to all are also documented.

3.5.1 Requirements by Airspace Users from Met Providers

All types of airspace users want to be provided with meteorological information. The interaction of high altitude general aviation sports flying within en route airspace was given as an illustration of the need.

Human factors need to be considered in the design of ground and airborne weather presentation displays using data from ground based weather radar stations.

A specific need for research is identified into means of improving the effectiveness of meteorological information especially in limiting weather conditions (e.g., fog) which affect operations and on aspects such as the contribution of meteorological services (actual and short term forecasts) to operations including stacking priority.

3.5.2 Requirements by Airspace Users and Met from ATM

Various airspace users as well as weather service providers recommend that the previous Met requirements work which has been undertaken, by the FAA in particular, be used for checking the relevance of the various requirements.

The weather service providers and the airspace users require that the issues of authority, responsibility and control of raw meteorological data (i.e., checking) be addressed and resolved in order to avoid the potential use of different meteorological data by different agencies. The airspace users require uniformity of meteorological data provided by the various Met services. Similar integrity and quality control requirements exist for the verification process (against actual weather) of meteorological products (nowcasts and forecasts). Those requirements further imply common formatting and coding for meteorological data provided to or by ATM.

3.5.3 Requirements by Met from Users

The weather service providers require from the airspace users the provision of *checked* raw meteorological data.

Some specific requirements on airline companies and equipment providers regarding meteorological data collection and validation include the definition of the checks to be performed on raw (unprocessed) data in order to avoid sending patently erroneous data.

For ATM applications, the meteorological services need more accurate data to feed their high resolution meteorological models in order to produce better predictions. Levels of accuracy are to be determined depending on specific requirements.

Meteorological service providers' requirements for the ground-based processing of remotely sensed data (satellite, radar, wind-profilers, lightning detection) need to be developed.

3.5.4 Requirements by Met from Airspace Users and ATM

Requirements by weather service providers from airspace users and ATM as a channel transmitting the weather information for airborne acquisition of meteorological data need to be assessed considering factors such as quality, quantity, level of accuracy, data density needs of the meteorological models and cost of data transmission and processing. Moisture content information is required in aircraft reports by the weather service providers. Meteorological data should be "smoothed" (over a time period depending on aircraft location and flight phase) within the aircraft systems.

Since meteorological data and forecasts are perishable, their creation and distribution have timeliness requirements. The role of ATM in the creation and distribution of such weather data and products imposes on it similar requirements for temporary storage means. The uplinking of meteorological

data to aircraft will generate needs regarding data volumes, measurement / update frequencies and procedures for exchange of such data between airborne platforms and ground sites. Weather service providers emphasise this timeliness requirement from airspace users and ATM regarding the provision and distribution of meteorological *data* whereas the users want from the Met service providers timely meteorological *products*.

3.5.5 Requirements by Airspace Users and ATM from Met

Meteorological data integrity, accuracy and timeliness are important factors to be considered in the provision of weather data and products within ATM and to the airspace users.

For ATM providers and aircraft operators, there is a need for special meteorological forecasts affecting airports (e.g. wake vortices, runway conditions, gust, windshear, snow).

3.5.6 Requirements by Met to other ATM Stakeholders

Facilities for the intermediate storage of meteorological data, aerodrome products and atmospheric data are required by weather service providers.

3.5.7 Requirements by Met to Potential Providers

An increase of the number of enhanced aeronautical weather stations around airports is sought by the weather service providers. This requirement is addressed to potential providers of meteorological data such as states or airport administrations.

3.5.8 General Standardisation Requirement

The weather service providers require compatibility of forecast information from different sources to allow maximum exchange of data. This requirement applies to the weather products (nowcasts and forecasts) in addition to raw data.

3.5.9 General Requirements

Improved exchange of research information is needed between meteorological offices, airlines and ATM. This requirement is expressed by every partner to the other ones.

Weather service providers see a need for cost benefit assessments particularly regarding the partnership of ATM and meteorological providers. Cost benefit studies related to the cost of achieving particular levels of accuracy are required. This requirement is also expressed by all partners. As any improvement induces additional cost, it is very important to evaluate the costs to achieve a given level of accuracy.

A better understanding between air traffic controllers, meteorological observers, forecasters and pilots is required on meteorological issues. This general requirement points out the importance of human factors like the dialogue between pilots, ATC officers and various people involved in the production of weather information.

4. THE ATM 2000+ WORKSHOP HELD IN 1998

The first issues of both the Operational Concept Document (OCD) and the ATM Strategy for 2000+ were intended primarily as consultation material to generate debate and help build a consensus on how ATM in Europe should develop. The documents had been given a wide circulation and comment invited, and received, on the content. Nevertheless, it was felt that the informal and wide-ranging discussions generated in a Workshop would be a valuable source of further views and positive contribution of material to support further and progressive editions of the OCD and 2000+ Strategy. With this in mind a five day workshop, aimed at the widest possible interested audience was held in February 1998. It attracted over 200 representatives from all sections of the aviation community, the ECAC States, airport operators, service suppliers and other organisations, many of whom were from the senior management levels.

The first part of the Workshop was targeted primarily at strategic decision makers and planners in the aviation community and involved presentations on the Revised Convention, the role of the Commission, and the proposed operational concept and strategy documents. This was followed by individual discussion groups covering a number of related strategy subjects.

During part 2, the Workshop split into a number of smaller expert level sub-groups to discuss the proposed target operational concept and ATM strategy in more detail and to address the requirements and trade-offs.

In general, the delegates confirmed the stakeholder needs recorded during the 1994 workshop, and the ATM2000+ Workshop allowed to discuss some additional topics described in the subsequent sections.

The material presented below was extracted from the workshop proceedings:

> **ATM2000+ Workshop Summary**
> EUROCONTROL doc. FCO.ET1.ST07.REP.01
> Edition 1.0 dated 19 March 1998

The interested reader should consult the proceedings to obtain information more detailed than the summaries included below.

4.1 General Comments Regarding the Interim Version of the ATM2000+ Strategy

The workshop participants discussed the first issue of the ATM Strategy for 2000+. The main messages emerging from these discussions were the following:

- There was general support for the line of thinking in the ATM 2000+ Strategy document.
- Participants wanted the objectives to be more ambitious, in particular, ASM. The approach proposed is pragmatic but a number of terms could be better expressed.
- In respect of ATFM there was wide consensus on the requirements and on the road map.
- There was a need for flexible capacity management especially through the tactical collaborative process.
- There was no doubt that the OCD and Strategy need to expand the airport element. This process might be helped by including the APATSI recommendation in the Strategy.
- Airport capacity was regarded as a major constraint.
- Collaborative decision making was essential
- A clear need to stress the role, and worth, of the human in the system.
- Set out clearly the responsibilities of all the actors/stakeholders
- Link enablers to the objectives
- Address global interoperability
- Willingness to find consensus in the decision making process and the commitment of all parties to change

4.2 Overall Workshop Conclusion

In his closing address the Chairman of the workshop, Mr Wolfgang Philipp stressed the importance of learning from the past and developing ATM as a system with the full involvement of the stakeholders. He also noted the importance of combining visionary thought with a pragmatic approach, and underlined the need to devise an ATM strategy for Europe that will fit within the ICAO global framework.

Mr Philipp also outlined the main messages that had emerged from the Workshop discussions. These were:

- the future ATM system had to be based on a benefit-driven approach supported by clear business cases and must incorporate measurable performance targets;
- safety was paramount and the need to improve safety levels in the face of increasing demand must be emphasised;
- environmental gains, together with any associated environmental related penalties, must be clearly spelt out in the Strategy;
- the right of access to airspace for all users must be a central objective;

- greater emphasis had to be placed on the need to increase airport capacity and airport and en-route capacity gains had to be balanced and remain in step if the full benefits of future investments were to be realised;
- collaborative decision making based on improved planning procedures and information management was an important key to a more efficient, flexible and effective ATM system and needed to be applied at both the strategic and tactical levels;
- the human, both in the air and on the ground, would remain an essential part of the ATM network for the foreseeable future and this had to be taken into account in the early design stages of the enabling systems and infrastructure;
- increasing the productivity of the air traffic controllers through the extensive use of computer support tools was a critical factor in finding the extra capacity needed;
- airspace management measures needed to be more ambitious and applied by all States. A 'Schengen' approach was needed;
- ATFM had to incorporate flexible capacity management and include consideration of gate-to-gate operations;
- Communications, Navigation and Surveillance systems had to be developed within a single coherent framework to more aggressive timescales;
- the role of essential services such as meteorology and AIS had to be recognised and statements concerning national defence needs and military requirements strengthened and expanded;
- implementation management mechanisms had to be clearly defined and rigorously enforced;
- R & D activities needed to support the strategy had to be identified and prioritised.

Since the workshop these messages have been passed on to and taken into account by the ATM2000+ Strategy Board during the compilation of the next version of the ATM 2000+ Strategy document.

Mr Philipp closed the Workshop by reminding the participants that the most consistent theme throughout the week had been the emphasis placed on the need for the commitment of all of the aviation stakeholders to measures set out in the strategy which should not become just a list of good intentions. He asked that all of the participants take this clear message back to their parent organisations, and to ensure that they were adequately prepared to review the next version of the strategy document prior to its presentation to the ECAC Transport Ministers in 1999.

4.3 Airspace Management & Flow And Capacity Management

4.3.1 General Issues

The Strategy presented to Ministers must provide a clear policy for European aviation which includes consideration of economic issues and clearly sets out the willingness and commitment of all sections of the aviation community to the changes involved.

Enhanced information sharing supported by improved information management to provide the basis for collaborative decision making at all levels is a key success factor in meeting future air traffic demand. There is a need for the aviation community to collectively elaborate the concepts and rules to be applied.

Responsive resource management is essential for the application of flexible capacity management and ATM managers must become more accountable for managing resources to provide the capacity needed to meet the demand.

4.3.2 Airspace Management

European airspace must be seen and managed as a continuum, a common resource for enhancing capacity and meeting demand; this requires a pan-European planning process which is developed to include both pre-tactical and tactical planning. The roles and mandates of the States and EUROCONTROL in this process must be clearly specified.

Willingness and commitment of states to implement airspace changes are the key issues. In this respect the proposed strategy show a lack of ambition. The notion of an Integrated European Airspace Planning in 2015 is behind the ministers declaration expressed in the ECAC INSTITUTIONAL strategy. There is a need for more ambitious targets: a “Schengen” for ASM.

The road map is a mixture of trends and specific targets. It contains number of elements which are in fact a continuous process (e.g. route optimisation). There is a need to define more specific implementation steps to which the states can be committed.

The need for a pragmatic approach is recognised. The right balance between local, regional and central management must be found and respective roles and responsibility must be defined.

4.3.3 Flow and Capacity Management

Airport capacity is seen as the main constraint in the future. Despite some uncertainties on the long term picture (where can extra capacity be found? what kind of system do we want? highly planned or Tactical?) a fair degree of consensus exists on the proposed improvements.

A main objective of the strategy is to provide the capacity to meet demand. The optimum operating point shall be defined by comparing the cost of extra capacity with the cost of delays. In many places capacity is running behind the demand which results in unjustified delays. More pro-active Capacity management is required.

On the tactical level, more flexibility is required to adapt capacity to peak demand. Responsive resource management is essential for the application of efficient capacity management.

Collaborative decision making could be promoted by better information sharing and real time data exchange between the different actors (AOC, CFMU, Airports, ATC Military Airspace Planners, Met, etc.). This should take account of the situation on the airport surface (low visibility, de-icing apron management, taxi times etc.), meteo information should also be considered.

4.3.4 Conclusion

The delegates supported the need for, and the main thrust of, the strategy. Gate to Gate, Flexibility and Efficiency, CDM, Capacity Management may be buzz words but these constitute a good starting point for the future.

Results of these discussions now need to be transformed into clear implementation steps and be supported by the commitment and willingness of all stakeholders.

4.4 Airports

The Concept and Strategy documents both highlighted airport capacity at the busier airports, and put forward solutions for optimising airport throughput by the introduction of new concepts and procedures supported by improved technology, such as Advanced Surface Movement Guidance and Control Systems and Arrivals and Departure Managers.

It was agreed that airport capacity was likely to be a major constraint on future traffic growth at some airports, and this issue should be accorded higher visibility in the Strategy document. It needed to be stressed that gains in en-route capacity had to be matched by improvements in airport throughput, or the benefits of the extensive investment required would not be fully realised. APATSI had identified measures which were low-cost and would bring immediate benefits but these had not been uniformly applied across the ECAC area. States should be encouraged to implement these measures and employ best practice to improve airport capacity, particularly in the short-term. Longer-term improvements would require improved ATM procedures based on technological advances. These had to be supported by integrated planning and implementation mechanisms.

Opinion on the need for the Strategy to address the provision of new airports and runways was mixed. The case for new airports and runways was still

unclear. Also, this was a political and institutional decision which could only be made by the States and airport operators concerned. The capacity gains to be made from the APATSI measures and new concepts and procedures would need to be fully investigated first. Additionally, many airports, particularly in regional areas, were still under-utilised. A major problem was a lack of consensus on what the shortfall was, and how it could be measured. Methods of measurement of capacity was not uniform and standard definitions were needed. Lessons could be learnt from the US in this field. They had produced a capacity handbook which set out capacity parameters for each airport.

The terms used to describe airport and other types of capacity (unconstrained capacity; integrated slot processes, etc.) need to be clearly defined and uniformly applied. Performance levels should be established for all groups of airfield activities and should be monitored.

EUROCONTROL could take an active role, and develop standard definitions and common capacity measurement models, as well as offering assistance to airports to resolve local problems based on best and standard practices. A single-point steering group and domain should be established.

However, it also had to be realised that airports were independent units driven by their own business priorities and aims. Although an integral part of the overall ATM solution, they could not be regarded just as a 'network' or solutions imposed. Issues such as airport slot allocation and interaction with ATM slots was a business issue and had to be handled locally. Likewise, any investment required to improve capacity would have to be matched by an equitable return. Means to increase airport capacity should include mechanisms to protect the commercial interests of all parties involved.

A problem to be resolved was what gate-to-gate actually means, and where responsibility for the various operational issues lay. The boundary between what could be achieved by ATM and what was needed from the airfield operators was not clear. The present strategy document said what needed to be done but gives no indication how it could be achieved. The revised document should give direction. Commitment was also an issue. It was not certain that the present method of using CIP objectives was the most appropriate.

Current actions were too fragmented. Longer-term improvements had to be carefully co-ordinated and airport operators must be fully consulted on future plans. The integration of improved surface management with tools such as Arrivals and Departure Managers was essential. Environmental considerations also had to be taken into account, as did wake vortex parameters, but these were not the only issues which impacted on capacity. Met had to be included.

The key to resolving the airport capacity problem was collaborative decision making based on good communications and the involvement of all of the

stakeholders concerned, i.e. airport operators, airspace users and ATM providers.

The airport operators had to be fully integrated into the communications loop - this was best handled at local levels by local consultation groups. The Workshop agreed that a clear message had to be given to Ministers. This should be that the present hub organisation cannot meet future needs and secondary hubs will have to be developed. The costs of not meeting the future growth should also be clearly spelt-out.

4.5 Air Traffic Control & Human Factors

Most of the delegates felt quite strongly, that although the strategy was, in general, heading in the right direction, there was very little chance of achieving it without an appropriate co-ordinating body to ensure effective and synchronised implementation.

The participants felt that there needed to be a better link between the operational improvements which were anticipated and the enablers necessary to achieve them.

There was a certain apprehension expressed with regard to the ability of the human to handle more traffic in airspace more densely populated than today, despite the expected improvements in system support and functionality. A general concern was expressed that the human controller would be pressured to use systems which were designed on the basis of technical solutions rather than of supporting the controller to do the appropriate job. This may result in the human controlling, but not being an integral part of the loop. It was suggested that a more human oriented approach was necessary in ATM2000+, and a suggestion was made that EUROCONTROL should be more active in the area of Human/System integration and should consider publishing standards for HMI.

These comments also extended to the safety aspects, concerning the degree of system automation and the ability of the human being to be able to successfully use the information. In particular, the aspect of system failure, and the controller's ability to recover the situation was of considerable concern to many of the participants.

With regard to greater levels of automation in the system, and the greater interaction with airborne and ground systems, it was generally felt that a greater control (certification) on the ground based systems would become necessary, in the future.

Comments were made that the ATM2000+ was focused on the core area of ECAC. Many countries have borders with non-ECAC countries and will be forced to maintain appropriate co-ordination and co-operation with those countries. The ATM2000+ does not seem to address this issue in any real detail.

The handling of military flights is not treated in great detail. The military participants felt that a system-wide treatment for military flights should be an essential part of the strategy.

Other issues involved:

- the policy on how cross-border problems related to sequencing concepts would be handled,
- how to develop a homogeneous working practice for all controllers,
- establishment of general rules and the distribution of timely information to all parties,
- How to incorporate safe and graceful degradation.

4.6 CNS and Other Systems

Overall, the delegates were pleased that a Strategy had been proposed and that there was a road map to the future. However, there was a feeling that air to air communication, especially use of ADS-B had not been emphasised enough in the current edition of the Strategy.

Any transition plan must be sensitive to airlines ability to invest. Capital expenditure has to be justified in CNS terms. Already airlines are looking to invest to the year 2000 and beyond. Indeed, an expected life of 30 years for some technology is not unusual. However, it is realised that there are bound to be new developments. Nevertheless, bearing in mind the costs involved in new technology, incremental development, rather than introducing completely new technology could be a possible way ahead. Following from this is the need for world-wide consultation and the principle of global interoperability to be addressed. Airlines certainly do not wish to have to fit different avionics for different airspaces. By the same token both the air and ground elements should be developed and implemented concurrently. There is little point installing expensive equipment, either in the aircraft or on the ground, if it cannot be used.

There may well be benefit from early implementation of existing technology. Rather than waiting for a “big bang” implementation, an early indication of a preferred system/procedure could go some way towards easing the current demand and capacity difficulties. On the other hand any implementation must bring benefits otherwise it may be money wasted. Nevertheless, with limited implementation it is possible that benefits can become quantifiable. In this respect there was a feeling that the need was to clarify which of the candidate systems are going to be adopted.

Whilst recognising the value of the proposed Strategy some delegates felt that the timescale could have been more aggressive. However, it was pointed out that development of procedures, setting of standards, assessment of business cases, research and development and so on, took time and the suggested timescales were probably quite reasonable.

Within the overall CNS domain data link was seen as a critical element. There could be benefit from early use of pilot/controller data link. It might be possible to increase controller productivity and thus capacity. As always the question of the medium for data link arose and with it re-emphasis on the desirability of early decisions on standard equipment.

A clear enablers upgrade path with visible priorities should be established to show airspace users where and when long term benefits can be expected.

Specific messages:

- The development of Surface Movements Ground Control Systems and concepts should be accelerated to help improve airport capacity.
- Implementation of Air Ground Data Links should be accelerated within the framework of ATN to provide earlier benefits.
- End-to-End requirements for interoperability should be covered by a clear standardisation and certification process.
- The strategy for the transition from ILS to new precision approach and landing systems (as developed at the ICAO Regional Meeting in 1994 and accepted as a Global Strategy in 1995) should be included in the Strategy.
- A programme should be established for the removal of superfluous air and ground equipment (e.g. ADF, NDB, VOR).

4.7 Integration & Information Management

Another group of delegates specifically discussed the strategic issues surrounding future ATM integration from a technical and information point of view, focusing in particular on how the subject of 'system-wide information management' (SWIM) could best be addressed in future ATM developments. The group's conclusions can be summarised as follows.

Up to now, many of the integration efforts have concentrated on improving interoperability at the communication and interface level. If this trend continues, the ATM network will become integrated in the system sense, but not in the information sense. The 'Point-to-Point Information Exchange Model' worked well in the past 50 years, but will become less and less suitable in the future operational environment where an increasing number of players ('Information Providers') generate information which is used for situational awareness and decision making by increasing numbers of 'Information Consumers', in ways and at locations which are not foreseeable at system design time.

Collaborative Decision Making (CDM) will become an essential and central element of future ATM at both the strategic and tactical levels. Advanced information sharing capabilities are an essential ingredient to the success of CDM.

Through a number of past and ongoing projects, progress has been, and is being, made to improve the situation for particular categories of information (AIS information, flight plans, surveillance data, flight data etc.). This is laudable and delivers early benefits, but a piecemeal approach will not bring the level of 'system-wide' integration that will ultimately be needed in the long run (2015 target), both within the ATM network, as well as with its external partners (aircraft operators, airports, air defence, MET service providers, etc.).

In other words, the current approach leads to integrated systems and internally well integrated islands of information, but not to the system-wide web of ATM information (the 'virtual information pool') which is needed to implement the gate-to-gate philosophy.

The discussions in the group revealed that there are quite a number of strategic 'Information Management' issues which warrant a 'horizontal domain' activity across all functional domains and individual projects. To establish a coherent and visionary approach, there is a need for a system-wide information management strategy to be developed.

The group also concluded that although meteorological issues were discussed during the 1994 user requirements workshop, little had been done since then to address future European MET/ATM integration needs. The subject should be included in the Strategy and required:

- incorporation of a meteorological strategy into the ATM 2000+ document;
- adequate representation from the meteorological community in the EATCHIP/ATM2000+ working structures. *(The MET community had offered to make the necessary effort available).*

4.8 Targets & Trade-Offs

Under the heading 'Targets & Trade-offs', the delegates discussed the main objectives and targets of the future ATM network; the conflicts between high level requirements of the requirements of different users and the trade-offs necessary to solve them with a view to improve the ATM 2000+ Strategy.

4.8.1 Confirmation of Key Objectives

- Safety: Zero ATM accident is a realistic target for the planning period; this implies incident monitoring as a basis for corrective action, managing risk & target setting. Need to clarify ATM accountability for other a/c hazards, e.g. CFIT.
- Capacity is a complex mix with network effects. It includes the following:
    - **Access** to airspace & ATM services measured via unaccommodated demand

- **Delay,** the most visible outcome of capacity shortfall
- **Predictability,** essential to maintain airline schedules; padding for systematic delays is built in airline schedules, but variance on the day disrupts schedules.
- **Flexibility**, ability of ATM to accommodate changing user needs in real time.
- **Flight Efficiency,** deviation from 4D preferred trajectory; however, individual flight optimum may not be always top priority.

- Cost-Effectiveness: ATM service charge is only part of "total" ATM-related cost; production cost increases for enhanced services should be subject to business case; it is expected that productivity will bring lower "production costs"
- Uniformity: uniformity & Commonality of equipage, systems & procedures within ECAC will bring economy of scale. With USA, Europe should drive global convergence in ICAO.
- Environment: an efficient ATM should contribute to aviation emission targets, as a global as opposed to regional European solution, but noise/pollution at airports subject to principle of subsidiarity.
- National Security: ATM will support national security needs, at all times; this includes efficient integration of civil-military ATM, interoperability, FUA fully dynamic and large scale civil reconfiguration capability.

4.8.2 Trade-Offs

The discussion on trade-offs demonstrated that this is a very complex matter, difficult to prioritise on a theoretical level. A number of topics were covered. They are summarised below.

Trade-offs on objectives

Capacity is the main priority after safety, the latter being fundamental to keep public confidence in aviation and a condition of business. Within capacity, the key points for the airlines are first the access to airspace, i.e. the possibility to realise flights, then the ability to respect a schedule (delay and predictability). Individual flight efficiency tends to be more important when the aircraft is operated close to its range/payload limits.

For the delegates, it was vital to keep European aviation competitive. This leads to pressure on ATM costs.

The users are ready to trade ground hold delay for increased airport capacity.

It was agreed in the subgroup that a capacity margin/headroom permits flexibility; this implied in effect a cost trade-off, but it was more favourable than the situation of capacity shortfall, provided that the extra capacity remained within the reasonable limits where it could be used to improve one

of the capacity characteristics. Full FUA and airspace optimisation are seen as vital enablers to create the necessary capacity headroom.

Centralised vs. local planning/decision

The airspace users and airport operators in the subgroup expressed a strong opposition to an integrated gate-to-gate scheduling, seeing it at a negation of their entrepreneur freedom. This view was made assuming airspace capacity was not the blockage. They advocated that airport scheduling should stay local if possible. For them, airport capacity utilisation was a local issue as opposed to a centralised imposition. ATM, through collaborative mechanisms, should advise on the consequences of interfering with local plans and the impact of ATM capacity.

Structure vs. freedom

This is essentially route network vs. free routeing. In a free route environment offering more efficient routings, a reduction in the number of conflicts was expected which could be used to offer more flexibility.

A structure was not perceived as necessarily bad. It was recognised that capacity had to be seen in relation to ATCO workload, and that structure was a means of designing out recurring traffic problems. In particular, it was agreed that one-way routes, etc. in TMA were key to high capacity.

Airspace users expected that a number of constraints would be relaxed thanks to more efficient ATM tools.

Individual vs. collective optimum

Concerning the issue of individual user vs. network-wide optimum, the viewpoint were different for airlines and ATM, but both looked about overall ATM network performance as the main driver. The notion of individual optimum was for airlines that of the fleet/flight programme optimum rather than that of individual flights. Finally, system optimisation was different from subsystem optimisation, and it was felt that a systemic approach should be considered to avoid not making the right choice, but that, conversely, the aviation partners could not have all the same objectives, nor sacrifice unilaterally their aspirations.

Mandate vs. incentives

It was considered that equipment mandating was acceptable when there was a strong safety case. Otherwise, business cases were seen essential to build consensus and should be made prior to decision making; more transparency and early involvement was confirmed to be a strong user requirement.

An issue was that each proposed improvement cannot always make all airspace users winners; it was likely, as recent experience shows, that there would be users in different airspace user classes or within the same class for

which the cost/benefit ratio would not be favourable, while a mixed mode of operations would mean that ATM could not deliver the anticipated benefit. Mechanisms and criteria would need to be found to handle these situations.

The use of differential service or pricing as solutions was evoked; this was seen as having a major impact on the charging system/method and a number of secondary effects which would need to be addressed before a recommendation is made.

It was stressed that the ANS charges should remain cost, not market related.

Other issues

The following points were also raised:

- there was a need for a common philosophy on the understanding of delays, stacks, holds and their use to ensure maximal system throughput.
- FUA and cross state ASM optimisation were expected to generate significant capacity increases with “little” technology; FUA must and can deliver benefits to both civil and military users; barriers to further expansion of FUA were felt to be more of a social or mental attitude nature.

4.9 Discussion on ‘Managing The Transition’

During the workshop a presentation on the management of the transition was given by EUROCONTROL.

In the discussion that followed the presentation the point was made that there should be more emphasis in the Strategy document on the management of the transition. To have EUROCONTROL act as the managing agent on behalf of States, with States being responsible for local implementation was a positive way to go forward. Indeed, the EATCHIP CIP process could be enhanced for this purpose. Furthermore, it is desirable that the CIP Objectives are consistent with the ATM Strategy and implementation objectives should be linked to performance targets. Whilst the CIP had been successful as a means of co-ordinating planning between States there must be clearer, stronger commitment from the States towards collaborative decision making.

The financing of the infrastructure was discussed. It has yet to be decided how common developments can be financed. There is no doubt that ATM will have to be run as a business. Furthermore, implementation of the Strategy will be constrained as much by finance as by environmental or other possible constraints.

ATM 2000+ has to make it easier for stakeholders to use common products, share common development and costs. It was felt that a common architecture

agreed early in the concept development would be helpful in this regard. However, as many European States do not have the financial or human resources to “go it alone’ in development, or even upgrading, of ATM systems collaboration becomes not only desirable but essential.

The collaborative decision making process is seen as having 2 levels. At the institutional level Ministers have started the process by expressing their wishes for the problems of capacity and delay amongst others, to be addressed. Decisions may not all be unanimous, indeed it will be the case that the common good must prevail in which case majority decisions will have to carry the day. In other words not everybody can have exactly what they want. At the operation level and in a gate to gate context, collaborative decision making involving all of the actors will be the vehicle by which the operational objectives of the Concept will be achieved.

5. OTHER RELATED WORK

5.1 The ADORA Study

During 1996-1997, the European Commission (DG VII) sponsored a relatively small study called ADORA (Analysis and Definition of Operational Requirements for ATM).

The study aimed at the identification of ATM requirements and relevant constraints refining the definition of user requirements and their compilation into a user database. Applying feasibility criteria, the ATM requirements and constraints have been compared against the user requirements.

ADORA started with the collection of ATM requirements & constraints, utilizing work done at ICAO level, within European Community funded activities as well as Member States and Eurocontrol (FANS, FEATS, ATLAS, AEGIS, PHARE, EATMS...). Moving from these a check on their comprehensiveness was performed and a textual database has been produced.

Then the definition of User Requirements phase has followed, mainly based on the European ATM User Requirements Document (URD). The study identified and complemented airspace and non-airspace user requirements.

A check on the adequacy of user/operational requirements, aiming at comparing user requirements with the proposed operational requirements has been performed in two steps, and has been stored in a custom designed database.

Readers interested in the results of ADORA should contact the European Commission, DG VII, attn. Mr. Lars Lönnberg (tel. +32-2-296.83.36, e-mail lars.lonnberg@dg7.cec.be).